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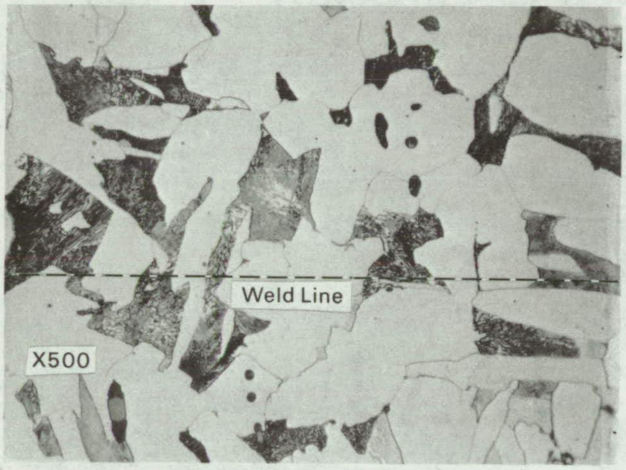
Practical Method of Diffusion-Welding Steel Plate in Air

A relatively simple method of diffusion-welding AISI 1020 steel plate in an air-atmosphere furnace at a pressure of 5 psi (with deadweight loading) has been developed. First, flat faying surfaces are pro-



AISI 1020 Steel Weldment

Diffusion weld made at 2000°F, 5psi, for 2 hours after auto-vac cleaning at 2200°F for 2½ hours. This weldment was double-normalized at 1650°F after diffusion welding.

duced by grinding. The faying surfaces are then degreased and aligned for seal welding in air. The seal weld is made around the periphery of the joint using a shielded metal-arc welder. The assembly is placed in a furnace and the faying surfaces are cleaned by heating the assembly at 2200° F for 2 1/2 hours with no external pressure or deadweight loading. In this process, called "auto-vac" (autogenous-vacuum) cleaning, the surface oxides and adsorbed gases are diffused or dissolved into the parent materials and away from the faying surfaces. This produces autogenously cleaned surfaces and a vacuum within the sealed gap. The diffusion weld is then produced in an air-atmosphere furnace at 2000° F for 2 hours under a deadweight pressure of 5 psi.

Welding can also be accomplished by combining the auto-vac cleaning and diffusion-welding procedures by heating the seal-welded parts to 2200° F for 2 hours under a deadweight pressure of 5 psi.

Tensile and bend tests were performed on joints diffusion-welded by the one-step and two-step procedures. The welds produced by these procedures could not be detected by mechanical testing. Failure occurred in the parent material in tensile tests, and the side bends were sound. These diffusion welds are also difficult to detect metallographically, as evidenced by the photomicrograph shown in the figure.

In the welding of heavy steel members, this diffusion-welding method may have economic advantages over the submerged arc, electroslag, or other welding techniques. It may also be ideal for critical service requirements where parent-metal properties must be equaled in notch toughness, stress rupture and other characteristics. With variations, the welding technique may be used on a variety of materials, such as carbon steels, alloy steels, stainless steels, reactive and refractory materials (in inert atmospheres), ceramics, and glass-to-metals. Metals that form stable oxides or brittle phases at the weld line, such as the precipitation-hardening nickel-base alloys and maraging steels, are not easily welded because the oxide cannot be removed readily by auto-vac cleaning and the precipitate produces a brittle joint. For these materials, it may be desirable to apply a thin coating of nickel or other suitable material to the faying surfaces prior to seal-welding.

(continued overleaf)

Notes:

1. This diffusion-welding method offers particular advantages for steel welding in industry since vacuum furnaces, hot presses or welding machines (except for seal-welding) are not required, and diffusion-welding conditions can be easily duplicated.
2. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA TN-D-6409 (N71-30524), Practical Method for Diffusion Welding of Steel Plate in Air
3. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B71-10455

Patent status:

No patent action is contemplated by NASA.

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